Instructions to mimic improve facial emotion recognition in people with sub-clinical autism traits

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Abstract

People tend to mimic the facial expression of others. It has been suggested that this helps provide social glue between affiliated people but it could also aid recognition of emotions through embodied cognition. The degree of facial mimicry, however, varies between individuals and is limited in people with autism spectrum conditions (ASC). The present study sought to investigate the effect of promoting facial mimicry during a facial-emotion-recognition test. In two experiments, participants without an ASC diagnosis had their autism quotient (AQ) measured. Following a baseline test, they did an emotion-recognition test again but half of the participants were asked to mimic the target face they saw prior to making their responses. Mimicry improved emotion recognition and further analysis revealed that the largest improvement was for participants who had higher scores on the autism traits. In fact, recognition performance was best overall for people who had high AQ scores but also received the instruction to mimic. Implications for people with ASC are explored.

Key words: Emotional expression recognition; Facial mimicry; Autism spectrum; Facial feedback; Embodied cognition.

Introduction

Facial expressions are contagious particularly among affiliated people. A facial expression of an emotion typically produces similar facial reactions in observers – that is, there is automatic mimicry of an observed facial expression. Dimberg (1982) provided empirical support for automatic mimicry using electromyography (EMG) to measure facial reactions. Dimberg found that when viewing pictures of happy faces, participants showed more activity in the facial muscles associated with smiling (zygomatic muscles). Further, when viewing angry faces, participants showed more activity in muscles associated with frowning (corrugator muscles).

For many people, mimicry of facial expressions is automatic and spontaneous, but the amount of facial mimicry that takes place is variable between people. Sonnby-Borgstrom (2002) found that people with greater emotional empathy tend to produce stronger EMG responses at congruent facial muscle groups when observing emotionally expressive faces. Also, facial mimicry is stronger when the participant is in an emotional state congruent with the emotion being shown. For example, it was shown that when in a fearful state, participants would mimic a fearful face more than an angry face (Moody, McIntosh, Mann & Weissner, 2007).

The role that this facial mimicry plays, if any, has been considered in detail but without resolution. As Hess and Fischer (2013) put it, there are two potential roles that facial mimicry may play. The first role is that it may act as ‘social glue’. Mimicking another’s emotional expression or having one’s expression mimicked binds people together in social groups. This suggestion would imply that mimicry does not play a role in the recognition of emotions but is more to do with social regulation. The second possible role for facial mimicry is that it is involved in the recognition of emotions and hence related to the reading of the minds of others. Emotion recognition is guided by multiple processes (see Adolph, 2002) but the idea considered here is that facial mimicry helps the process in a measurable way. This second role for mimicry, therefore, is that is aids emotion recognition. These two possibilities for the role of mimicry are explored here starting with the latter.

The mimicry-aids-recognition hypothesis

There is considerable recent interest how mimicry might aid emotion recognition but some would argue that the idea goes back at least to the writing of Lipps (1907). Lipps proposed that to perceive a person’s anger or sadness we have to experience it ourselves. Wallbott (1991) combined Lipps’ ideas with mimicry studies to suggest that imitation has an impact on the process of emotion recognition. Goldman and Sripada (2005) developed these ideas further and proposed the reverse simulation model (amongst other possible frameworks that operated in a similar fashion). Niedenthal, Mermillod, Maringer and Hess (2010) developed the concept linking it to theories of embodied cognition.

The idea that mimicry aids emotion recognition is grounded in facial feedback theory. This idea was originated by Darwin (1872) and states that the outward expression of an emotion can initiate or intensify the feeling of that emotion. Research by Laird (1974) has shown that emotional states can be affected by activation of certain facial muscles even if participants are unaware that they are forming a particular facial expression.

It can be argued that this facial feedback, when combined with mimicry leads to improved emotion recognition. First, an observer mimics the facial expression of another individual in a subtle manner. Second, the corresponding emotional state is generated in the observer via the facial feedback mechanism – that is, the emotion forms from the embodiment of the expression. Finally, the observer infers the other individual's emotional state from their own emotional state. This results in emotion recognition. This route necessarily requires action-specific simulation (see Press and Cook, 2015) as the exact same facial muscles need to be active in order to establish to correct categorization of expression rather than just that an emotion has been expressed. Here we are agnostic as to the neurological underpinnings of this process but there is evidence that mirror neurons may have a role to play (see Enticott, Johnston, Herring, Hoy & Fitzgerald, 2008).

This route to facial expression recognition has various stages without which it could not be a viable mechanism. Evidence for these stages is presented here.

In order for the embodied cognition model of emotion recognition to work there needs to be feedback from one's facial muscle activation to one's feeling of affect. There is growing evidence for such facial feedback based on studies such as that by Strack, Martin and Stepper (1988), which showed that forming a smile produced more positive evaluations of cartoons even if the smile was constructed without awareness using a pen held between the participants' teeth. Further, Lewis (2012) showed that specific posed facial expressions could feedback to feelings of depression, surprise and disgust. It is shown, therefore, that making a facial expression, even if one is not aware that one is doing so, can feedback to help support that feeling of affect.

For further support for the embodied cognition model of emotion recognition, it is necessary to look at the evidence for facial mimicry in more detail. Since Dimberg's (1982) study, a number of different studies have demonstrated that facial expressions elicit the same facial reactions in observers. In Wallbott's (1991) study, participants were initially asked to judge the emotions expressed in pictures of facial affect (Ekman & Friesen, 1976) whilst being filmed without their knowledge. Two weeks later, the same group of participants watched the videotapes of their own expressions during the judgment task. Participants were asked to judge which emotion they had been judging, using only information about their facial expression contained in the videotape. Results indicated that participants were able to judge which emotion they had been looking at from their recorded face at levels considerably above chance. This indicated that the participants were mimicking the expressions that they saw to such an extent that were able to detect this mimicking on their own faces.

The use of electromyography (EMG) has been used many times to establish the role that mimicry plays when observing facial expressions of emotion. Blairy, Herrera and Hess (1999) examined participants' facial movements using EMG whilst completing an emotion recognition task. They found that participants did spontaneously mimic the target facial expression and reported the corresponding emotions. However, a methodological limitation of such correlational work is that it is impossible to establish whether facial mimicry is an aide to or a consequence of emotion recognition. Another problem with EMG studies is that it draws participants' attention towards their own facial actions.

Oberman, Winkielman and Ramachandran (2007) offer support for the embodied cognition model by identifying a causal role for facial mimicry. Using a pen-biting method forblocking facial mimicry, Oberman et al. (2007) found that emotion recognition was impaired. This finding was strongest for the recognition of happy emotional expressions with some evidence for recognition of disgust also being impaired. Similar results were found by Ponari, Conson, D'Amico, Grossi & Trojano (2012) in that controlling the contractions of facial muscles impaired the recognition of happiness, disgust, anger and fear. The specific recognition impairment was influenced by which sets of facial muscles were contracted. The recognition of surprise and sadness were not affected, possibly because the correct set of facial muscles was not contracted within the experimental paradigm. Also, Niedenthal, Brauer, Halberstadt and Innes-Ker (2010) showed that the experience of seeing an emotion on a face (shown as a video with gradually reducing expression) disappeared sooner if mimicry was not allowed to take place. Recently Ipser and Cook (2015) demonstrated that interpretations of smiles were impaired when participants voiced aloud vowel sounds during judgments. Experiments that involved listening to vowel sounds rather than making vocalisations confirmed that this loss of perceptual sensitivity was a consequence of the motor action rather than the sound produced. Together, these studies provide critical support that facial mimicry plays a role in expression recognition and reducing this mimicry affects one's ability to make emotion recognition judgments.

There has been considerable research into the emotion recognition abilities of people with autism spectrum conditions (ASC)[1]. Solid conclusions on their performance, however, are hard to come by. They tend to have lower levels of empathy and it has also been argued that their recognition of facial emotions is different from typically developing people. For example, a study by Yirmiya, Kasari, Signman & Mundy (1989) showed that people with ASC experience difficulty labelling emotional exprerssions. Similar results are reported by Gross (2004) and Grossman and Tager-Flusberg (2008). Other studies, however, demonstrate that people with ASC can perform just as well as typically developing people in such tasks (e.g., Loveland Tunali–Kotoski, Chen, Ortegon, Pearson, Brelsford & Gibbs, 1997; Robel, Ennouri, Piana, Vaivre-Douret, Perier, Flament & Mouren-Siméoni, 2004).

One explanation for the differing findings is that any impairment in emotion recognition is a result of alexithymia rather than the ASC itself (see Bird & Cook, 2013). Alexithymia is a difficulty in describing one's own emotional state and it is comorbid with ASC (Hill, Berthoz & Frith, 2004). Cook, Brewer, Shah and Bird (2013) showed that people with alexithymia are able to perceive differences in expressive faces but it is the interpretation of these differences that is impaired. People with alexithymia may not gain any advantage from the act of mimicking an emotional expression as they would not gain any additional emotional feedback from doing so.

Harms, Martin and Wallace (2010) also tried to reconcile the variety of emotion recognition results from people with ASC. They suggest that although people with ASC may not be able to recognize emotional expressions in a typical way, they will have generated compensatory mechanisms. Such mechanisms could vary between individuals but might use explicit cognitive processes or processes that are verbally mediated such as a piecemeal analysis of facial features. Some of these mechanisms might not work under certain conditions (for example they might break down under speeded tasks). These compensatory mechanisms explain why performance of people with ASC is as good as typically developing people in at least some tasks.

[1] The term autism spectrum condition (ASC) is used here rather than the term autism spectrum disorder (ASD). The Autism Research Centre (n.d.) describes the term ASD as being "stigmatizing and pejorative". For some people, autism can be a disorder and a disability but for others it is something that just makes them different. The term 'condition' recognises both these differences and the possibility that it can be disabling for some people.

There is convergent evidence that the degree of mimicry of expressions is reduced in people with ASC. Hermans, van Wingen, Bos, Putman and van Honk (2009) found that, when presented with an emotionally expressive face, women with higher autism traits scores showed less spontaneous facial mimicry than typically developing people. This study used electromyography to measure facial action in response to angry and happy faces. No difference in mimicry was found across levels of autism traits if the participants were instructed to mimic the face seen. A similar difference was found across genders by Beall, Moody, McIntosh, Hepburn & Reed (2008). In this study, however, older people with ASC did begin to show mimicry for happy faces but not to the same degree as typically developing people. Further, Rozga, King, Vuduc and Robins (2013) examined facial expressiveness in individuals with ASC when viewing clips of happy, angry and fearful displays. People with ASC showed no significant differences between activity of the zygomatic and corrugator muscles across emotions unlike typically developing individuals. Studies by McIntosh, Reichmann-Decker, Winkielman and Wilbarger (2006) and Oberman, Winkielman and Ramachandran (2009) found that while people with ASC showed a delayed and degraded spontaneous facial mimicry relative to typically developing people, they were able to produce congruent facial mimicry when overtly instructed to. Also, people with ASC have been shown spontaneously to produce appropriate facial expressions in response to evocative visual images (e.g., erotica or mutilations, see Mathersul, McDonld & Rushby, 2013).

The evidence from people with ASC appears to be that they can develop skills at facial-emotion recognition and these skills, in some tasks, can be equivalent to typically developing people. However, people with ASC do not tend to produce facial mimicry spontaneously even though they have the ability to do so. If facial mimicry is advantageous for facial-emotion recognition then whatever mechanism that people with ASC do use must be at least as good as mimicry.

The mimicry-as-social-glue hypothesis

An alternative view to the embodied cognition model of emotion recognition is that facial mimicry is not a mechanism for facial-emotion recognition but tool for social bonding. This is a notion discussed by Hess and Fischer (2013) as emotion mimicry in context. As such, mimicry plays the role of social glue and is only appropriate in certain situations such as between friends. So, a smile from an enemy is unlikely to be mimicked because of the context. Some support for this point of view comes from the fact that EMG responses in facial muscles have been found in response to congruent emotional sounds (Hawk, Fischer and van Kleef, 2012). The argument is that where support for mimicry aiding recognition does exist, it is based on just happiness and anger. As such, it is the congruence of the valence of the emotion that leads to the observed advantage rather than the matched emotion being expressed.

As stated above, a counter-argument to the mimicry as an aid to emotion recognition is the mimicry-as-social-glue idea (Hess and Fischer, 2013). This suggests that the role of mimicry is not to aid recognition and, if correct, then we can reinterpret the performance of people with ASC. The fact that people with ASC do not show facial mimicry would not mean that they would require different processes to interpret facial expressions. They could be making the same kinds of decisions, but they are not using mimicry to reinforce the social bonds of the interaction. Effectively, the mimicry-as-social-glue idea predicts that mimicry, in itself, will not help the recognition of emotional expressions. A lack of mimicking could represent a lack of affiliation with other people or poorer social bonds.

Experiment 1

The present study sought to investigate the effect of promoting facial mimicry on facial emotion recognition and as such provide further evidence for the embodied cognition model. A normal adult population with varying autistic personality traits was used in the current study. Autistic personality traits are traits that are present in normal-functioning adults and, to a greater degree, those diagnosed with ASC and include such things as difficulties in social interaction (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). This is related to the idea of a broader autism phenotype in that people may have autism-like characteristics to a varying degree of severity (for example, see Austin, 2005). Insight into the relationship between facial feedback and emotion recognition in persons with these personality traits provides a basis for the understanding of this same relationship in patients diagnosed with ASC. None of the participants in the current experiment would be classified as having an autism spectrum condition but the variety of their autistic personality traits allows for the exploration of differences in a sub-clinical population. The Autism-Spectrum Quotient (AQ; Baron-Cohen et al., 2001) questionnaire was administered to all participants to assess their autistic personality traits. This assesses the extent to which an adult has the traits associated with the autistic spectrum. In the AQ, autistic traits are grouped into five areas: Social Skill, Attention Switching, Attention to Detail, Communication and Imagination. These assess different aspects of autistic traits but, here, a single cumulative measure of AQ is reported and analyzed. The AQ has been shown to have good diagnostic validity (for example see Woodbury-Smith, Robinson, Wheelwright & Baron-Cohen, 2005) and reliability (for example see Hurst, Mitchell, Kimbrel, Kwapil & Nelson-Gray, 2007). All participants were then required to complete a facial-emotion-recognition task in order to establish a baseline level of performance. Subsequently, participants were assigned to either an intervention group or a no-intervention group. In the intervention group, participants were told to mimic the facial expression that they saw before they made an emotion-recognition judgment. Care was taken not to encourage or discourage mimicry of expressions except in the intervention condition..[2]

It was hypothesized that promoting facial feedback via mimicry would improve scores on the facial-emotion-recognition task relative to controls that did not receive instructions to mimic. Furthermore, it was predicted that the mimicry intervention would have a greater effect on those participants with higher AQ scores. This second hypothesis follows because it was predicted that participants with higher AQ scores are less likely to spontaneously mimic the viewed facial expressions.

Method

Participants

Forty-six Psychology undergraduates (four of whom were male) took part in the study for course credit. All participants were between the ages of 18 and 25 years old. Participants were randomly assigned to one of two conditions: the intervention condition (N=23) and the no-intervention condition (N=23). One participant was removed from the no-intervention condition as performance in the second half of the study was at a near chance level suggesting disengagement with the study.

Materials

Measure of Autistic Personality Traits. The Autism-Spectrum Quotient (Baron-Cohen, Wheelwright, Skinner, Martin & Clubley, 2001) was used to assess autism-like traits. This is a 50-item self-report measure, consisting of a series of self-descriptive statements.

Facial Emotion Recognition test. A Facial Emotion Recognition (FER) task was made using the images generated by Bowen, Morgan, Moore and Van Goozen (2014). The images were generated from six individuals showing the six universal emotions in the Ekman and

[2] EMG recording was not employed here because it was considered that placing electrodes on the participants' faces could prime facial muscular action and this would interfere with the main manipulation of the study. Similarly, a fully counter-balanced design could not be used as giving people instructions to mimic prior to asking them to do the task naturally would have carry-over effects between the two conditions: that is participants might (and probably would) continue to mimic in the second condition.

Friesen (1976) set. From these original images, morphs with the neutral face of the same identity were generated to vary the emotion intensity. The levels of morph used here were 25%, 50%, 75% and 100%. The test, therefore, involved 144 images (six identities by six emotions by four levels of intensity). During the test, the participants made forced-choice responses as to which emotion they thought was being shown: 'Happy', 'Sad', 'Fear', 'Anger', 'Disgust' or 'Surprise'. Each image was presented in a random order on a computer screen until a keyboard response was made that was coded as either correct or incorrect.

Design

The study used a between-participant design in a baseline-intervention-re-test format. The independent variable was whether participants were assigned (randomly) to the intervention (i.e., told to mimic the faces shown) or no intervention condition. A quasi-independent variable was the participants' AQ score. The dependent variable was proportion of correct responses in the Facial expression recognition task. A power analysis was conducted based on a similar task. This suggested a sample size of 23 participants for each condition.[3]

Procedure

All participants were tested individually and began by providing informed consent and then filled in the AQ questionnaire. Following this, participants completed the FER test sat at a computer. Images were presented on a screen until the participant made a judgment as to which emotion was being displayed and recorded that judgment via a key press of the relevant labelled key. If participants were assigned to the no intervention condition then there was a short break before they did the FER test a second time. If participants, however, were assigned to the intervention condition, they were instructed to mimic the facial expression of the target face before responding during the subsequent FER test. No justification was given to participants for this instruction. Following the conclusion of the task, participants in the intervention condition were asked, "How well did you mimic the faces that you saw?" Participant's responses were recorded on a 5 point scale (Not very well to Very well) as is

[3] In order to do a power analysis to calculate the sample size, it is necessary to have a predicted effect size. As this experiment had not been previously carried out an analogous experiment was identified. For this, the observed correlation observed between the AQ score and another emotion recognition test (the Reading the Mind in the Eyes test) was used. This comparison was chosen because the aspect of the results on which conclusions would be drawn is the correlation between the performance change measure and the AQ score. Baron-Cohen, Wheelwright, Hill, Raste and Plumb (2001) reported a correlation of 0.55, which suggested a sample size of 23 for each condition in the current study.

standard practice in facial feedback research (see for example Strack, Martin & Stepper, 1988). All participants scored 4 or 5 on this scale and so none were rejected.

Results

Demographics

The AQ scores for the participants ranged from 4 to 26; the mean was 15.8 with a standard deviation of 6.6. While none of the participants are in the range that would be considered to be likely to have an autism spectrum condition (i.e., they were all less than 32), there was variability in the scores and so it is possible to assess the effect that differences in AQ scores have on the intervention. The average AQ score in the intervention group was 15.0 (sd = 5.8) whereas it was 16.6 in the control group (sd = 7.5). This difference was not significant, $t(44) = .817$, $p = .418$. All of the participants in the intervention condition reported having been able to mimic the faces that they saw (all 4 or 5 on the 5-point scale). Analysis of performance at baseline found a non-significant correlation between AQ score and baseline FER score, $r = 0.032$, $p = 0.835$.

ANOVA on conditions

The majority of participants (83% in the invention condition and 35% in the baseline condition) did better at the FER in the re-test than at baseline. Means and standard deviations are shown in Figure 1, which shows an interaction between intervention and time of test. An ANOVA performed on these data found this interaction to be significant, $F(1,43) = 23.3$, MSE = 331.9, $p < 0.001$. The main effect of intervention type was not significant, $F(1,43) = 1.507$, MSE = 229.9, $p = 0.226$, but the difference between baseline and re-test, $F(1,43) = 7.081$, MSE = 100.6, $p < 0.05$ was significant.

Regressions including AQ

Further insight was generated by analyzing the difference between performance at re-test and the baseline and using this to form the dependent variable for the purposes of analysis. Figure 2 shows the pattern of these differences split according to the intervention and scores on the AQ questionnaire. This figure reveals larger differences in the intervention condition for participants with higher AQ scores. These difference measures were employed in two multiple regressions, described below. The first explored the effect of AQ score and condition and the second also include the baseline facial expression recognition performance as a predictor. The analyses also included interaction terms where appropriate (Aiken, West & Reno, 1991).

In the first regression analysis, the dependent variable was improvement in performance over the two tests (re-test score minus baseline score) and the independent variables were the intervention condition, the participants' AQ scores and the interaction between these two. This initial model revealed a significant fit to the data, R squared = .502, $F(3,41) = 13.762$, MSE = 315.3, $p < 0.001$. The intervention manipulation was not significant. $t(41)=0.748$, $p > 0.05$, and the AQ score was significant, $t(41)=2.329$, $p<0.05$; however, these results need to be taken in context of a significant interaction, $t(41)=3.071$, $p<0.01$. In order to investigate the interaction, separate simple regressions are reported for the intervention and the control group following the methods described by Aiken, West and Reno (1991). Such an analysis reveals the degree of the simple relationship at just one level of the intervention type variable similar to a simple main effects analysis in a factorial ANOVA. For the control group, there was no significant relationship between AQ score and size of difference in FER scores, $r = 0.134$, $t(20) = 0.606$, $p > 0.05$, but for the intervention group there was a significant and strong relationship between AQ score and size of difference in FER scores, $r = .595$, $t(21) = 3.395$, $p < 0.01$.

It could be argued that the increases seen in the differences in the FER scores for the people with higher AQ scores are being carried by the fact that they have a lower initial emotion recognition ability. In order to counter this argument, the regressions were repeated with the baseline scores on the FER as a predictor of the difference in performance. In this analysis, the global fit of the model was significant, R squared = 0.555, $F(5,39) = 9.715$, MSE = 209.1, $p < 0.001$. The intervention condition, $t(39) = 1.464$, $p > 0.05$, FER scores, $t(39) = 1.086$, $p > 0.05$, and the interaction of the baseline with the condition were, $t(39) = 1.691$, $p > 0.05$, not significant. The AQ score, $t(39) = 2.505$, $p < 0.05$, and most importantly the interaction between AQ score and condition, $t(39) = 3.268$, $p < 0.05$, remained significant predictors of difference in performance.

Discussion

The present study sought to investigate the effects of instructions to mimic emotions on facial emotion recognition in a normal population, but with varying degrees of autistic personality traits. This was to test the idea that mimicking emotional expressions leads to improved recognition of the expression being shown. The first observation is that there was only a weak positive correlation between AQ scores and performance on the baseline facial expression recognition test. As explained above, this finding can be compatible with an embodied-cognition role for facial mimicry. It is possible that people use different compensatory mechanisms to do such tasks (Harms et al., 2010) and so while performance levels might be same, the methods employed could be different.

The more important finding is that the simple act of instructing a person to mimic the expression being shown leads to an increase in emotion-recognition performance, as shown in the ANOVA. Further, this improvement is found to be most marked in people who score highly on the AQ, as shown in the regression analyses. One explanation for this is that people with low AQ make some degree of facial mimicry spontaneously when they view an expressive face and as such any instructions to mimic will not lead to an improvement in performance. People with a higher AQ, however, might not spontaneously mimic and so overt instructions to do so will change their ability to use facial feedback as a tool for emotion recognition.

Experiment 2

One potential limitation of Experiment 1 was the lack of control over presentation time. The standard implementation of the FER is for response-ended viewing but this means that different participants may spend different lengths of time viewing the stimuli. In particular, it may be the case that participants who are instructed to mimic may view the images for longer and hence have more accurate recognition. This was remedied in Experiment 2 by having a fixed presentation time for stimuli throughout the experiment. In Experiment 1, 95% of responses were made within 1500ms and so this was taken as the fixed presentation time. A response could only be made after the image had disappeared from the screen.

A second concern with Experiment 1 was the nature of the control task in that it was comparing a condition with some instructions against a condition with no instructions at all. Any instructions may be leading to renewed attention in the task. Instead of there just being a short break, in Experiment 2, participants were asked to pay particular attention to the whole face prior to being re-tested on the FER. This provides an instruction without the key element of instruction to mimic the face seen.

Experiment 2 was conducted to attempt to replicate the findings of Experiment 1 but also to address these two limitations. A final difference was that the AQ-10 questionnaire was used rather than the 50 item AQ questionnaire. This is a 10-question measure of autism traits and shows very good correlations with longer measures (Allison, Auyeung & Baron-Cohen, 2012). This is a more efficient measure of general autism traits but does not have the same ability to evaluate the five areas that the AQ measure employed in Experiment 1 has. As these analyses do not make use of this finer level analysis, the AQ-10 was considered to be more appropriate to use here. Research has shown that the AQ-10 has good diagnostic reliability (Allison et al.) and changing the measure for this partial replication also helps with the construct validity of the research findings.

Method

Participants

Sixty Psychology undergraduates took part in the study for course credit (eight were male). All participants were between the ages of 18 and 25 years old. Participants were randomly assigned to one of two conditions: the intervention condition (N=30) and the no-intervention condition (N=30).

Materials

The Autism-Spectrum Quotient was measured using the AQ-10 (Allison, Auyeung & Baron-Cohen, 2012). The same Facial Emotion Recognition task was used as employed in Experiment 1 (Bowen, Morgan, Moore and Van Goozen, 2014).

Design

The same baseline-intervention-retest design was used as in Experiment 1. In one group, participants were given the instructions to mimic as the intervention whereas in the control group they were told to look at the whole face. As in Experiment 1, the dependent variable was the accuracy of emotion recognition.

Procedure

Participants completed the AQ-10 and then were presented with the FER test. In this test the images were presented for 1500ms before they disappeared and the participant could respond as to which emotion they thought was being displayed. Following the first test, the participant was either told to mimic or copy the facial expression being shown while it was on the screen (mimic group) or pay particular attention to the whole face (control group) before making their response. The participant then repeated the FER test with the same fixed viewing times. Finally, the participants in the mimic group were asked how well they thought they mimicked the images seen on a five point scale. All participants scored 4 or 5 on this scale and so none were rejected.

Results

Demographics

The AQ-10 scores for the participants ranged from 0 to 8; the mean was 3.2 with a standard deviation of 1.6. The average AQ score in the intervention group was 3.2 (sd = 1.4) and also in 3.2 in the control group (sd = 1.7). Analysis of performance at baseline found a significant negative correlation between AQ score and baseline FER score, $r = -0.420$, $p < 0.001$.

ANOVA on conditions

The majority of participants (77% in the invention condition and 60% in the baseline condition) did better at the FER in the re-test than at baseline.. Means and standard deviations are shown in Figure 3, which shows an interaction between intervention and time of test. An ANOVA performed on these data found this interaction to be significant, $F(1,58) = 4.07$, MSE = .004, $p < 0.05$. The main effect of intervention type was significant, $F(1,58) = 5.148$, MSE = .064, $p < 0.05$, and so was the difference between baseline and re-test, $F(1,58) = 10.274$, MSE = .011, $p < 0.05$.

Regressions including AQ

Further insight was generated by analyzing the difference between performance at re-test and the baseline and using this to form the dependent variable for the purposes of analysis. Figure 4 shows the pattern of these differences split according to the intervention and scores on the AQ questionnaire. This figure reveals larger differences in the intervention condition for participants with higher AQ scores. These difference measures were employed in two multiple regressions, described below. The first explored the effect of AQ score and condition and the second also include the baseline facial expression recognition performance as a predictor. The analyses also included interaction terms where appropriate.

In the first regression analysis, the dependent variable was improvement in performance over the two tests and the independent variables were the intervention condition, the participants' AQ scores and the interaction between these two. The intervention manipulation was not significant, $t(56) = 1.157$, $p > 0.05$, and the AQ score was not significant, $t(56) = 1.629$, $p > 0.05$; however, these results need to be taken in context of a significant interaction, $t(56) = 2.29$, $p < 0.05$. In order to investigate the interaction, separate simple regressions are reported for the intervention and the control group. For the control group there was no significant negative relationship between AQ score and size of difference in FER scores, $r = -0.092$, $t(28) = 0.487$, $p > 0.05$, but for the intervention group there was a significant and strong relationship between AQ score and size of difference in FER scores, $r = .461$, $t(28) = 2.749$, $p < 0.01$.

The second regression, which included the baseline performance as a predictor, found the same pattern of results with the interaction between AQ score and instructions to mimic being significant, $t(55) = 2.21$, $p < 0.05$. Analysis of this interaction confirmed that AQ predicted the increase in performance in the mimic condition, $t(27) = 2.634$, $p < 0.05$, but not in the control condition, $t(27) = 0.143$, $p > 0.05$, even when baseline performance was considered.

Discussion

The results from Experiment 2 replicate the findings from Experiment 1. Instructing a person to mimic the face being observed improves the recognition of the emotion being shown. Further, this improvement is most effective for people with higher autism traits. The fixed presentation times, used in Experiment 2, rules out the explanation that it is just that the instruction to mimic means that participants will study the images for longer. Also, the change to instructions given to those in the control condition means that the absence of any instructions as an account for the findings in Experiment 1. Hence, it can be clearly concluded that instructing a person with higher autism traits to mimic the face scene will improve their facial emotion recognition performance.

One difference between Experiment 1 and Experiment 2 was in the correlation between baseline performance on the FER and the AQ measure. This correlation was not significant for Experiment 1 and significant for Experiment 2. Indeed, a Fisher test to compare these finds a significant difference between the two correlations, $z_{\text{diff}} = 2.36$; $p < 0.05$. The difference between these two is that the first offers open-ended viewing of the stimuli whereas the second had a fixed presentation time. These different results can be resolved by considering that people with higher AQ scores may require longer periods of exposure in order to obtain the same level of performance as people with lower AQ scores. This is possible in the free-viewing design of Experiment 1 and so no correlation is observed; the fixed-exposure design of Experiment 2 means that these longer viewing times are not possible and so performance is poorer for people with higher AQ scores.

Another difference between the results of the two experiments was that in Experiment 2 performance there was a significant simple effect of intervention whereas in Experiment 1 there was no significant evidence such a simple effect. Differences of this nature are not problematic as they demonstrate that an effect might not always reach the level of significance. There are, however, sufficient differences between the two experiments to explain why the performance might differ. In Experiment 1 the length of trials was determined by the participant and so if they respond quickly then the experiment ends faster and they still get their credit. Less attention may be paid in such a design compared with Experiment 2 where the experiment does not end earlier if the participant responds faster.

General Discussion

The results of the two experiments show that the instructions-to-mimic intervention increased overall performance on the expression-recognition task to a greater extent than the improvement seen in the control condition. This finding provides support to the embodied-cognition model of emotion recognition (e.g., Wallbott, 1991): copying a facial expression allows a person to feel that expression and therefore identify it more clearly. However, it is impossible to discount the possibility that the instructions to mimic may have had an effect on performance that is unrelated to the actual mimicry – for example, producing a different scan pattern or changing the length of time different features are viewed (although Experiment 2 means that total viewing time can be ruled out). While this remains a possibility, it is still intriguing that the size of the improvement correlates with the person's AQ score. Whatever the actual mechanism, the instruction to mimic improves recognition for those people with higher AQ scores.

In some ways, the finding that instructions to mimic can lead to an improvement in facial-emotion recognition can appear to be surprising. Studies show that people tend to automatically and spontaneously mimic facial expression even without instruction (Blairy, Herrera and Hess, 1999). It would also be expected that this spontaneous mimicry would have developed to do the task at an optimum level. However, not all people spontaneously produce mimicry and the literature shows that people with ASC tend not to use facial mimicry as much (Beall *et al*. 2008). As such, one would expect people with higher AQ scores to be less likely to spontaneously use facial mimicry. In the current study, the size of the benefit of the instructions to mimic was correlated with the person's AQ scores: That is, people with more autistic traits tended to be the ones who benefited from receiving the instruction to mimic. One interpretation for this is that people with low AQ scores tend to spontaneously mimic facial expressions and so would not show any advantage when instructed to mimic but people with higher AQ scores are less likely to spontaneously mimic and so the instructions lead to mimicry that consequently improves recognition through embodied cognition. Figure 2 shows that the upshot of this is that emotion recognition performance is best for those people who have higher AQ scores but are also instructed to mimic. These people would benefit from any compensatory processes that they may have for emotion recognition as well as the feedback that they might get through mimicry. People who use spontaneous mimicry but are still poor at emotional expression recognition do not benefit from further instructions to mimic presumably because they are already gaining the advantage that mimicry confers.

Alternative explanations of the findings are possible. Maybe, the instructions to mimic lead to an improvement in performance for higher AQ participants because it requires attention to different regions of the face – or indeed, attention to the face at all. Such an explanation would not require an embodied cognition explanation of improved performance but it still shows that a simple intervention can improve performance. Further experiments employing eye tracking may help discount this explanation, but even if the eye-tracking performance is the same, that is no guarantee that attention is not affected by the instructions to mimic. Another potential problem with the design is that it lacks ecological validity. The differences observed could be due to changes in the level of effort that people make during a repeated emotion expression recognition task. Such a task may be different to a one off evaluation of a real three-dimensional face. However, this kind of criticism could be levelled at almost any study hoping to understand the recognition of emotional expressions.

The current study has potentially interesting theoretical implications. The findings support the embodied-cognition model of emotion recognition (e.g., Wallbott, 1991). While it is possible to recognize a facial expression of emotion purely through pictorial analysis, it appears that mimicry of the face does provide an advantage. Being overtly instructed to mimic a face's expressions confers a benefit upon some judges. This is not to say that mimicry in social settings is not important as well in terms of binding affiliates. Mimicry may still help to glue groups together in the way described by Hess and Fischer (2013) but this is not the only role that mimicry plays.

The exact mechanism by which instructions to mimic improves emotion recognition for people with higher AQ scores can only be speculated from the current findings. For example, people with alexithymia have higher AQ scores and it could be that it is this factor, rather than any other autistic trait that leads to the observed pattern. Further studies will be required to disentangle what aspect of the AQ leads to benefit that instructions to mimic have for emotion recognition. This would include consideration of whether the mimicry advantage aids the perception of the facial action or the interpretation of this action. Designs similar to that employed by Cook and colleagues (2013) could be employed to elucidate this issue.

The fact that the instructions to mimic provide a significant advantage in emotion recognition tasks for people with higher (but sub-clinical) AQ scores has practical implications. If we take these people as a model for those with ASC then it is possible that these results might generalize to the clinical population. It will be important to extend these results to participants with ASC in the future. If the benefits of instructions to mimic do extend to people with ASC then this provides a potential intervention in order to improve social communication and empathy in this group.

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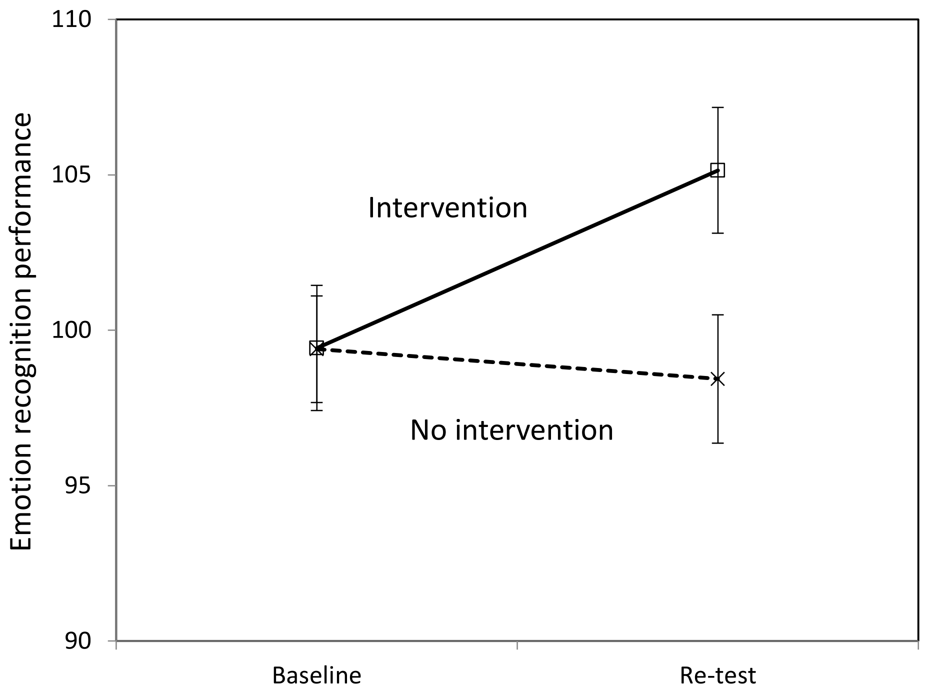

Figure 1. Average performance on the facial expression recognition test in Experiment 1. Data are split according to time of testing and intervention. Maximum performance would have been 144 for correct responses to all 144 images in the task. Error bars show 1 standard error.

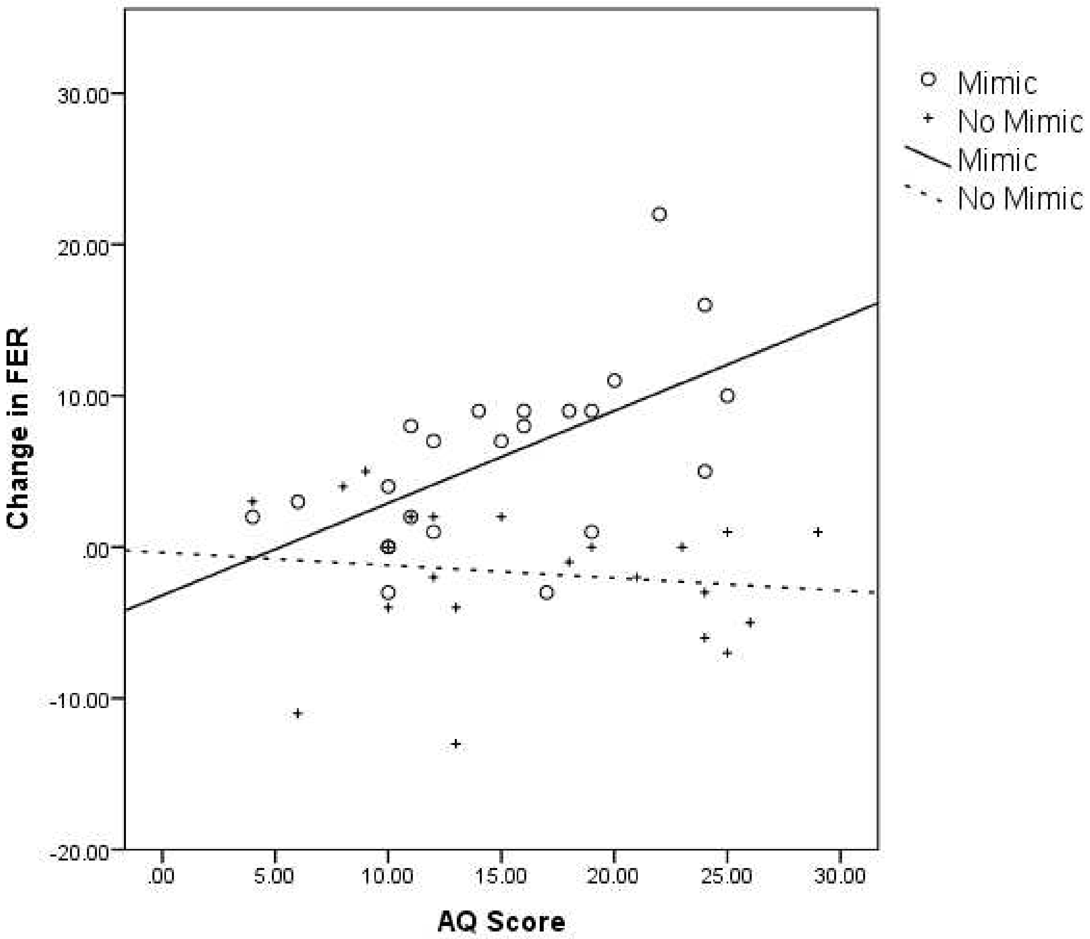

Figure 2. The change in face expression recognition performances between post-test and baseline in the facial expression recognition test as plotted against AQ scores in Experiment 1. The circles represent participants who received the mimic instructions at post-test whereas the crosses represent those who did not receive the instructions. The solid line of best fit is for the mimic instructed participants whereas the dashed line of best fit is for the control condition.

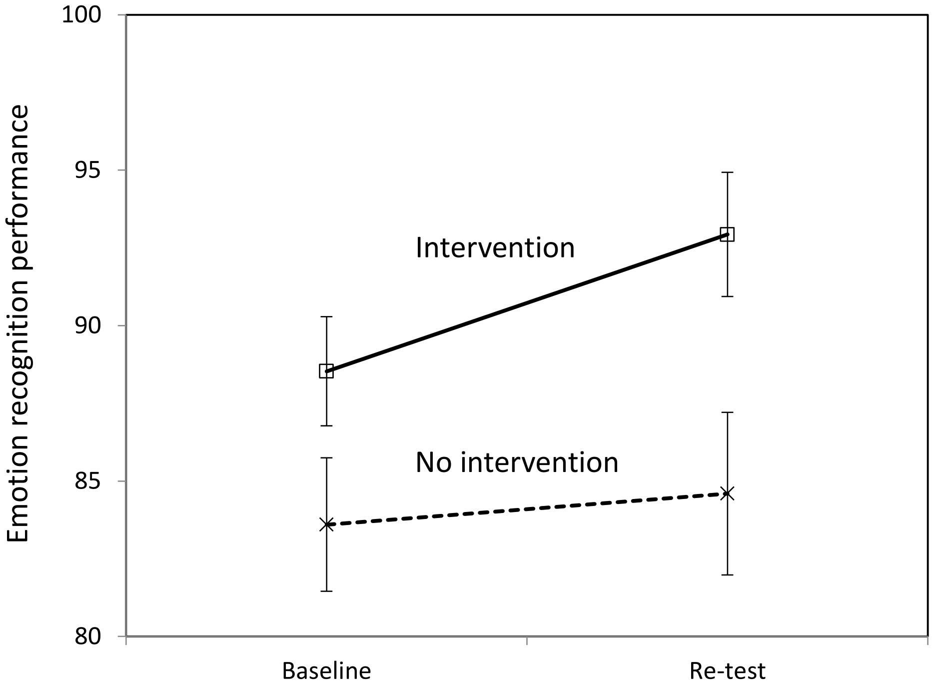

Figure 3. Average performance on the facial expression recognition test in Experiment 2. Data are split according to time of testing and intervention. Maximum performance would have been 144 for correct responses to all 144 images in the task. Error bars show 1 standard error.

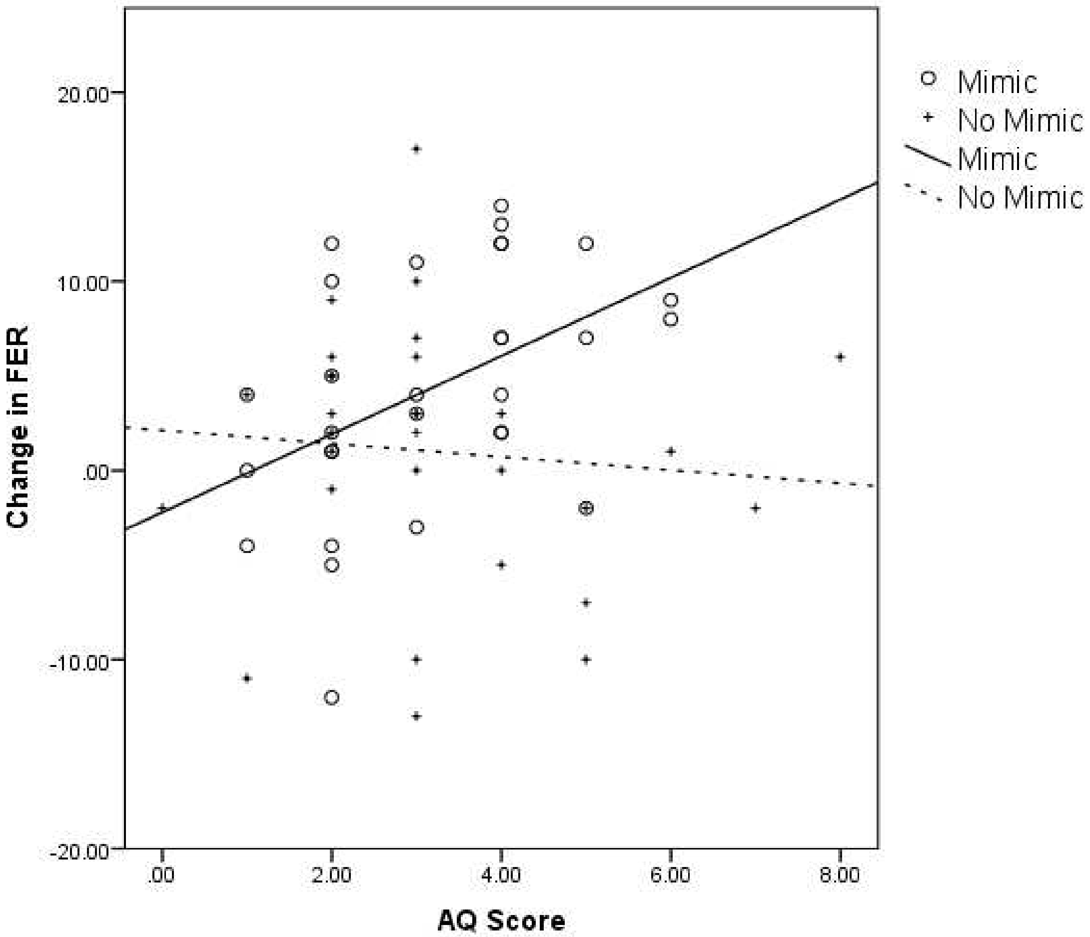

Figure 4. The change in face expression recognition performances between post-test and baseline in the facial expression recognition test as plotted against AQ scores in Experiment 2. The circles represent participants who received the mimic instructions at post-test whereas the crosses represent those who did not receive the instructions. The solid line of best fit is for the mimic instructed participants whereas the dashed line of best fit is for the control condition.